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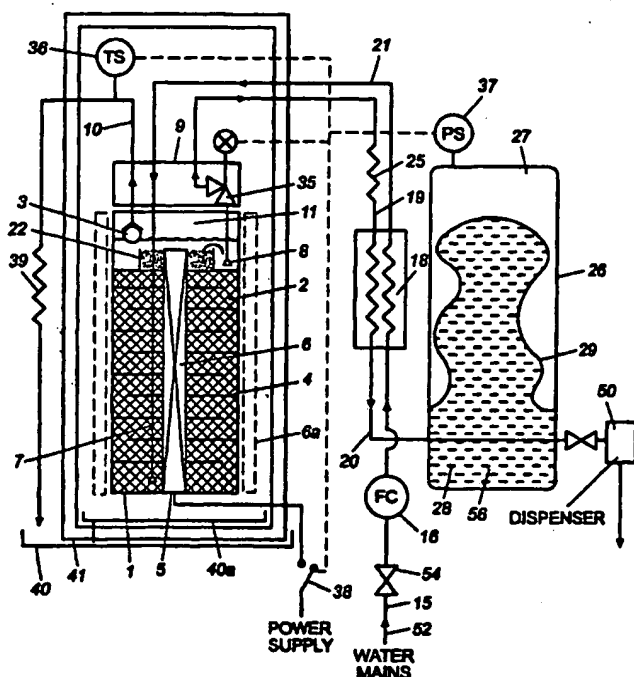
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(54) Title: ON PREMISE WATER TREATMENT SYSTEM AND METHOD



(57) Abstract: A water treatment method uses a removable, disposable cartridge (2) having an internal mesh structure. A disposable heater (6) heats water fed to the cartridge. Precipitated solids collect on the mesh surface provided temperature and residence time are appropriately maintained. The heat breaks down the bicarbonate hardness of the water thereby depositing carbonates on the mesh surface and heavy metals will be codeposited due to the resultant change in pH. The cartridge has a head-space (11) for collecting entrained gases such as volatile organic compounds, chlorine and air. Water sterility is achieved by heating the water over an appropriate period of time. Turbidity is removed within the cartridge due to settling induced by the low fluid velocity controlled by a controller and by a filter provided at the outlet of the cartridge. The filter will become blocked when bicarbonate hardness is carried over forcing a user to replace a spent cartridge. Heat economy and a cool treated water outlet stream are secured by use of a heat exchanger (18). Water is fed from the cartridge, through an intercooler and the heat exchanger to a storage tank (26). Water in the storage tank is kept out of contact with air by a movable barrier. Eventually, the water is fed from the storage tank to a dispenser (50) and can subsequently be used in a post-mix beverage dispenser. A visual display indicates the status of the water treat-

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ON PREMISE WATER TREATMENT SYSTEM AND METHOD**Field of the Invention**

10 The present invention relates to a water treatment system and method for use in a post-mix beverage dispenser.

Background of the Invention

15 In some locations, water sterility is a health issue, and restricts the use of on premise beverage preparation machines (generally referred to as "postmix" equipment). Where water is to be used in beverage preparation, excessive bicarbonate hardness is undesirable, since it reduces the acidity of the beverage and affects taste. Volatiles in water, such as organics and chlorine also can have an affect on its taste. Particularly hlogenated organics (trihalomethanes, generally described as THMs) have recently given rise to consumer concerns and
20 regulatory restriction. Suspended matter and turbidity reduces the quality of water both when consumed alone, and on mixing to produce a beverage. Finally, in certain locations, consumers have also shown concerns regarding the heavy metal content of water, and this too has been the subject of legislation in some countries.

25 Dissolved air in raw water, although not in itself a water quality aspect, can reduce the effectiveness of carbonation in post-mix equipment, and make dispensing difficult due to foaming. A means of deaerating water is advantageous for such equipment. It is noted that water deaeration is always carried out prior to carbonation in bottling and canning plants.

30 Therefore, a simple method for in-house, or instore, removal of microbiological contamination, bicarbonate hardness, volatile organic compounds (VOCs) - particularly THMs - as well as chlorine and heavy metals, is important for meeting certain consumer concerns, raising the quality of drinking water in some locations, and improving the taste of on premise prepared
35 beverages in certain outlets. Additionally, deaeration of water is highly desirable for post-mix outlets, and can lead to reduced foam on dispensing and better beverage quality. However, on premise water treatment systems must meet the following criteria:

- Low cost of original equipment;
- High reliability in absence of technical monitoring or controls;
- All the above-stated quality criteria (i.e. sterility, bicarbonate hardness, chlorine, THMs/VOCs, turbidity, heavy metals and desirably, deaeration);
- 5 - Simple, convenient, safe operation by nonqualified people (i.e. in-store or in-home);
- Low cost of maintenance and operation; and
- Low space-utilization.

10 Currently available systems for use in-home and/or in-store do not meet all the quality and other criteria. Such systems include carbon filtration systems. These systems only address chlorine and VOCs/THMs, but organics are effectively removed only when the filter is regularly maintained. When maintenance is poor, such devices can actually act as biological contaminators. Thus, carbon filtration systems can cause problems in one area while

15 inadequately addressing other areas.

Another conventional system uses reverse osmosis. Such a system addresses bicarbonate hardness, heavy metals and microbiological contaminants only. Reverse osmosis systems require significant maintenance. Moreover, VOCs/THMs are not treated and these together with chlorine, can actually

20 damage the reverse osmotic membrane and reduce its effectiveness.

Simple ion-exchange systems are also known. These systems normally address only bicarbonate hardness or, if more complicated, the total metal and salt content of water. However, these systems need regular maintenance such as the regeneration of the ion-exchange resin. If such maintenance is not carried

25 out, these systems can actually produce treated water of worse quality than untreated water. Chlorine is untreated and can damage the ion-exchange resins in these systems. Moreover, VOCs/THMs are untreated and microbiological contaminants are not only untreated but may actually be significantly increased due to microbiological growth on the resin.

30 Simple filtration has been used where turbidity is a water quality issue. Such filtration addresses this criteria only, and can increase microbiological contamination if not regularly maintained.

Water sterilization systems using chemicals are known. Such systems address only the microbiological contaminant criterion and need careful

35 maintenance to ensure that chemicals cannot pass into the treated water.

None of these above-mentioned conventional systems are easily maintained by the non-expert user. Moreover, all of these systems have significant penalties if the user fails to carry out proper maintenance. Although none of the above-mentioned systems meet the whole set of quality criteria discussed; all but the simplest and least reliable are costly both to buy and maintain.

U.S. Patent 4,844,796 to Plester teaches the principles of heat treating water. This system, however, includes carbon and sand filtration in a first cartridge section and further filtration and an activated carbon screen in a second cartridge section. It is desired to avoid such filtration and to expand the water treatment quality criteria.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide an improved method for treating all the water quality criteria named (i.e. microbiological contamination, bicarbonate hardness, VOCs/THMs, chlorine, turbidity and heavy metals).

It is a further object of the present invention to provide a method which is simple, cheap, compact, involves low and non-expert maintenance and has no water quality risk if the user does not properly maintain the system.

In this regard, it is a further object of the present invention to provide a method wherein the user is forced to take steps to maintain the system.

A further object of the present invention is to provide a method wherein the apparatus remains hot until treatment is completed to thereby avoid microbiological recontamination.

These objects are also fulfilled by a method of treating water for use in a post-mix beverage dispenser comprising the step of providing a housing having a collector, an inlet, an outlet and a head-space. The housing defines a water treatment chamber and receives water through the inlet. The method further comprises the steps of heating the water in the water treatment chamber for a predetermined period of time to break down bicarbonate hardness in the water and providing a collector on which precipitates from the water can be deposited. Gases disentrained from the water are collected in the head-space of the housing and released from the housing, and water from the outlet is received in a storage tank. The method further comprises the step of keeping the water stored in the storage tank out of contact with air or other gases in a headspace of the storage

tank by providing a collapsible water chamber including a movable hermetic barrier contacting the water in the storage tank and capable of following changes of water volume in the water chamber.

Moreover, these objects are fulfilled by a method of treating water for use
5 in a post-mix beverage dispenser comprising the steps of introducing water into a housing, the housing having a collector and a headspace and heating the water in the housing to break down bicarbonate hardness in the water. Carbonates are deposited on the collector and heavy metals are codeposited on the collector due to change in pH of the water. The method further comprises the steps of
10 collecting gases disentrained from the water in the head-space of the housing and maintaining the water in the housing for a predetermined period of time. The water is heated during at least the predetermined period of time. The water is then supplied from the housing to a storage tank and the water stored in the storage tank is kept out of contact with air or other gases in a headspace of the
15 storage tank by providing a collapsible water chamber including a movable hermetic barrier contacting the water in the storage tank and capable of following changes of water volume in the water chamber.

A method for satisfying these and other objects further comprises the step of introducing water into a housing or cartridge, the housing having a collector
20 and a filter. The filter has a shorter useful life than the collector. The water is moved through the housing with the water first flowing through the collector and then through the filter. The method further includes the step of heating the water in the housing to break down bicarbonate hardness in the water thereby depositing carbonates on the collector. The carbonates gradually reduce proper
25 functioning of the collector. A condition of the filter which changes as a function of the depositing of said bicarbonates thereon which will eventually block the flow of water through the filter is monitored. The collector will only partially be blocked when the filter is completely blocked such that water could flow through the collector but the flow of water through the collector is
30 prevented by the blocking of the filter. This blocked filter will therefore signal the need for maintenance of the collector.

According to another embodiment of this invention, a system for treating water comprises a water submersible heater disposed in a housing along with a solid precipitate collector. More particularly, the system comprises a housing
35 defining a water treatment chamber and having a water inlet for receiving untreated water and a water outlet for discharging treated water, the water

submersible heater, and the collector. The water submersible heater is disposed in the housing so that the heater is in direct contact with the water in the housing and the heater heats the water sufficiently to convert dissolved impurities in the untreated water to solid precipitates and gases. The collector is disposed in the housing for collecting the solid precipitates deposited from the water. Suitable water submersible heaters including an electrical heater. Desirably, the housing, collector, and heater form a disposable unit which can be disengaged from the system and replaced.

This invention also encompasses a method for treating water comprising feeding untreated water into a water treatment chamber defined by a housing through a water inlet in the housing, heating the untreated water fed into the water treatment chamber with a water submersible heater disposed in the housing, collecting the solid precipitates deposited from the water onto a collector disposed in the housing, and discharging treated water from the housing through a water outlet in the housing.

This invention also encompasses an embodiment wherein the polishing filter of the water treatment and system is a polyester wool filter. The polyester wool filter is relatively inexpensive and performs well.

According to still another aspect of this invention, a system for treating water is provided comprising a housing defining a water treatment chamber and having a water inlet for receiving untreated water and a water outlet for discharging treated water, a heater for heating the water in the housing sufficiently to convert dissolved impurities in the untreated water to solid precipitates and gases, a collector disposed in the housing for collecting the solid precipitates, a water cooler for receiving treated water from the housing water outlet, and a fan for forcing air pass the water cooler to cooler the treated water in the water cooler. More particularly, the system for treating water further comprises a gas outlet for discharging the gases from the housing and a condenser for receiving the gases discharged from the gas outlet. The fan is position for forcing air past the condenser to cool the gases in the condenser. This invention also encompasses the corresponding method wherein air is forced past a water cooler in a water treatment method to cool the treated water in the water cooler.

According to yet another aspect of this invention, a system for treating water is provided comprising a visual display for indicating a status of the system. Desirably, the visual display comprises a plurality of lights for

indicating the status of the system and is capable of indicating a plurality of possible statuses of the system. The statuses include the level of water in the housing, the level of water in the reservoir, the level of precipitate blockage in the fine filter of the system, the water discharge status, the system cooling status,
5 and the system power status.

More particularly, the visual display of this invention indicates when the water in the housing is below a predetermined level, when the water in the housing is above a predetermined level, when the water in the reservoir is below a predetermined level, when the housing discharges treated water, and when the
10 water in the housing is below a predetermined temperature.

Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only,
15 since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF DRAWINGS

20 The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

Figure 1 shows the basic apparatus used with the method of the present
25 invention;

Figure 2 shows an alternative arrangement for the product water storage tank of the present invention;

Figure 3 shows an alternative control system using electrical heating;

Figure 4 shows an alternative gas heating system of the present invention;

30 Figure 5 shows a reduced scale, perspective view of a cartridge used in the present invention;

Figure 6 is a perspective view of an alternative water treatment system made in accordance with an embodiment of this invention; and

35 Fig. 7 is a diagram of the visual display and control system of the water treatment system illustrated in Fig. 6.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring in detail to the drawings and with particular reference to Figure 1, the apparatus of the present invention is shown. This apparatus includes a removable/disposable housing or cartridge 1 having a mesh structure 2 and a float valve 3. The interior of cartridge 1 forms a water treatment chamber. The mesh structure 2 can be metal or plastic. The mesh structure 2 acts as a collector means through which water flows as will be described below.

Optional baffles 4 may be provided in the mesh structure 2 in cartridge 1. These baffles 4 guide the water along a tortuous path from one end of the cartridge 1 to another as indicated by the arrows. The baffles 4 can be either metal or plastic and will ensure good distribution, avoidance of short-circuiting and good particle settling.

In Figure 5, the toroidal shape of cartridge 1 can be seen. In other words, the cartridge 1 has a cylindrical shape with a longitudinal cavity 5. This cavity 5 is shown as terminating within the cartridge 1, but this cavity 5 could extend completely through the cartridge 1.

As Figure 1 shows, cartridge 1 is heated by an internal heater 6 or an external heating-mantle 6a (as indicated in dotted lines). The internal heater 6 is inserted into the centrally located cavity 5. While cartridge 1 is disposable, the internal heater 6 or heating-mantle 6a acts as a permanent heating means. The cartridge 1 is insertable on or into either of these heaters and is readily removable therefrom. It is contemplated that only one heater 6 or 6a will be used; however, both heaters can be used, if necessary. The external heating-mantle 6a can surround all of the generally cylindrical cartridge 1 or only a part of this cartridge. Of course, other heating arrangements should be readily apparent to those skilled in the art.

Internal pipes are arranged within the cartridge 1. These pipes includes inlet pipe 7 which ducts incoming untreated water to the base of cartridge 1. An outlet pipe 8 ducts the treated water from the top of the cartridge 1. These pipes 7 and 8 can respectively be considered as a water inlet and a water outlet to the water treatment chamber in cartridge 1.

The cartridge 1 is located within the apparatus by a removable head 9. Cartridge 1 can be screwed onto head 9 or attached thereto by any other suitable means. This head 9 and cartridge 1 merely need to be connected such that water

will not leak from cartridge 1. Suitable gaskets or O-rings can be used to ensure an hermetic seal between head 9 and cartridge 1, if so desired.

5 The head 9 contains the inlet/outlet water piping and a vent 10 for the gases as will be explained below. Vent 10 can simply be a pipe extending from the interior of the cartridge 1. The cartridge 1 is readily removable from an insulating mantle 41. This mantle 41 can easily be opened to provide access for changing cartridge 1.

10 Head 9 is removable from cartridge 1. The head 9 can be extracted from mantle 41 with the cartridge 1 or alternatively, can be separated from the cartridge 1 and remain within this mantle 41. Appropriate couplings (such as quick release couplings) are provided for the pipes 7, 8 and vent 10 so that these elements can readily be connected or disconnected to existing piping structure within the cartridge 1. Alternatively, these pipes 7, 8 and vent 10 can simply be inserted into the cartridge 1 when head 9 is placed on the mantle 41. One skilled
15 in the art should appreciate many different arrangements whereby the cartridge 1 can be readily inserted into and removed from mantle 41.

Untreated raw water indicated by numeral 15 enters the system through water main 52. This water passes through valve 54 and a mechanical flow control 16. Valve 54 can be omitted and control means 16 can act as the sole
20 inlet control between the water main 52 and cartridge 1.

The control means 16 controls flow of the water through the cartridge 1. The control means or flow control 16 will control the velocity of the water through the cartridge 1 such that the water will remain in the cartridge for a predetermined period of time, usually 1-60 minutes.

25 The water in inlet pipe 7 travels through a heat exchanger 18. The raw water 15 is heated by outgoing treated water indicated by numeral 19. This will reduce the temperature of product water 20 close to the temperature of the incoming raw water 15.

30 The heated raw water 21 will enter cartridge 1 and be ducted to the base of the cartridge by the inlet pipe 7. This water will then rise through the cartridge 1 being heated by the internal heater 6 or the external heating-mantle 6a. The water will rise to the level of the float valve 3 and will be ducted out of the cartridge 1 by the outlet pipe 8.

35 Gases disentrained within the cartridge 1 consists mainly of whatever VOCs/THMs, air and chlorine are dissolved in the raw water as well as carbon dioxide formed during the heat induced decomposition of bicarbonate. In

particular, volatiles will be removed due to the rise in temperature and attendant reduction in solubility of the water. These volatiles will also be removed by the stripping effect of dissolved air and nascent carbon dioxide generated by the breakdown of bicarbonate hardness.

5 Gases collect in the head-space 11 of the cartridge 1 and are released periodically together with steam by float valve 3. These gases are then vented through vent 10. Solids contained in the raw water 15, or formed by the decomposition of bicarbonates, or heavy metals whose solubility has been reduced, are deposited in the mesh structure 2 of cartridge 1. The bicarbonates,
10 heavy metals and any other precipitates from the water can be considered as certain precipitated solids which are collected by the mesh structure (collector means) 2.

In particular, precipitated solids collect on the surface of the mesh structure 2, provided the process criteria (temperature and residence time) are
15 appropriately maintained. The heat from internal heater 6 or heating-mantle 6a will break down the bicarbonate hardness, depositing carbonates on the mesh structure 2. Accordingly, the cartridge 1 is a reaction chamber in which bicarbonate is removed out of solution in the water by thermal decomposition, which changes the bicarbonate to carbonate and carbon dioxide. The carbonate is
20 insoluble and deposits as a hard "fur" (clinging sediment) on the mesh structure 2 and other hot surfaces within the disposable cartridge 1.

As will be explained below, these deposits eventually reduce the internal capacity of the cartridge 1 to a point beyond which the thermal decomposition can no longer be completed because the reduced space in the cartridge results in
25 a reduction in the treatment time available for the water in the cartridge. In other words, carbonates and heavy metals are codeposited and gradually fill up the cartridge 1 reducing its void space and thus reducing residence time of the water in the cartridge. The heavy metals are codeposited with the carbonates due to the resultant change in pH of the water. As the residence time is reduced, so is the time available for the precipitation to take place. At some point, when the
30 deposits have reached a certain level and the voidage within the cartridge has been reduced to a certain degree, there is no longer sufficient space in the cartridge 1 to achieve minimum residence time needed to complete the precipitation process. Then water with precipitable dissolved solids will enter a polishing ring filter 22. This ring filter 22 will be described in more detail
35 below.

As set forth above, the cartridge 1 has a free internal gas/liquid surface at head-space 11 where volatiles are collected and discharged by the internally operated valving device 3. The volatiles (VOCs/THMs and chlorine) are removed due to the rise in temperature and attendant reduction in solubility and also by the stripping effect of dissolved air and of nascent carbon dioxide generated by the breakdown of bicarbonate hardness. Water sterility is achieved by heating the water over an appropriate time period. Turbidity is removed within the cartridge 1 due to settling induced by the low fluid velocity controlled by the control means 16 and by the fine filtration mesh or filter 22.

The ring filter 22 is a filter means. The water at the top of the cartridge is ducted through this ring filter 22 which acts as a polishing filter. Cottonwool, fine sand and/or plastic granules, porous plastic or similar material can be used for filter 22. Any material suitable for fine, depth-filtration can be used for ring filter 22. The filter 22 will initially have a function of removing or polishing minute carry-over of solids in solid (i.e. non-dissolved) form. The filter 22 is arranged to be in contact with either the internal heater 6 or alternatively, the heating-mantle 6a. The water leaving the filter 22 will eventually enter the outlet pipe 8 and leave cartridge 1.

Bicarbonate escaping the mesh structure 2 (due to inadequate decomposition in cartridge 1) will deposit on filter 22. Until water with precipitable dissolved solids enters the ring filter 22, this filter generally only removes odd specks of escaping solid. In other words, carry-over of dissolved solids should not normally reach filter 22, since such dissolved solids should be deposited on mesh structure 2; however, when the voidage within the mesh structure 2 is reduced and the cartridge 1 is spent, precipitable dissolved solids will carry-over to ring filter 22. Since the ring filter 22 contacts the internal heater 6 and/or the heating-mantle 6a, it will be heated and the noncompleted precipitation will continue or be completed in the filter 22. Carry-over off dissolved-solids would normally pass through filter 22 and not affect it. Because ring filter 22 is heated, however, a postreaction is induced and the non-completed precipitation will continue or be completed.

Because the filter 22 has minute pores compared to the mesh structure 2, the filter 22 fills and blocks very quickly due to the carry-over. These deposits will signal the need to change cartridge 1. Such bicarbonates will decompose and block ring filter 22 rendering the cartridge unusable. The user will then be forced to exchange the cartridge for a fresh one.

Water would continue to pass through the mesh structure 2 except that the blocked filter 22 prevents such flow. In other words, if the filter 22 were not present, water would continue to flow through the mesh structure 2 and exit the filter. While some purification of the water would occur, the water exiting the cartridge 1 would not be adequately treated. Because filter 22 is present, water flow will terminate when this filter becomes blocked due to bicarbonates being carried over. The condition of the filter 22 will change as a function of the depositing of bicarbonates thereon. This condition of filter 22 can be monitored. When the filter 22 is eventually blocked, the user will therefore be automatically signaled of the need for maintenance of the mesh structure (collector means) 2. When the filter 22 is blocked, the cartridge 1 is basically spent and the cartridge outlet blocked. The user will therefore be forced to replace cartridge 1.

Water sterility is achieved with the present apparatus by heating the water over an appropriate period of time under the control of control means 16. Turbidity is removed from the water within the cartridge 1 due to the settling induced by the low fluid velocity and by the filter 22 provided at the outlet of the cartridge.

Outgoing treated water 19 passes into an air-cooler 25. This air-cooler 25 has a conventional fin-type construction for air cooling. Temperature of the treated water 19 is reduced by 5°C. to 30°C. This ensures that the outgoing treated water 19 no longer has a temperature which can cause bicarbonate decomposition and solid deposition within the heat exchanger 18. Such bicarbonate decomposition and solid deposition could render the heat exchanger 18 inoperative. Also, the air-cooler 25 will ensure that incoming raw water cannot be heated within the heat exchanger 18 to a temperature which would induce premature precipitation of dissolved solids in the incoming raw water, and thus lead to ultimate blockage inside the heat exchanger.

The heated raw water 21 leaving the heat exchanger 18 has a temperature which is 5°C to 30°C lower than the operating temperature of the cartridge 1. This water will quickly reach the correct operating temperature upon entering cartridge 1. A cool treated water outlet stream is secured with the present apparatus and method. The heat exchanger also aids heat economy such that a thermally efficient system is obtained. Also, by reducing the temperature of the treated water, overheating of a downstream dispenser having built-in refrigeration can be avoided.

The operating temperature in cartridge 1 is in the range of 90°C to 115°C, but may be significantly higher when the water contains a high proportion of sodium or potassium bicarbonates. The temperature is kept as low as practical, within the needs of treatment quality. This will enable the system to operate at a low pressure and to minimize energy consumption.

Preferably, the water will be fed by pressure from water main 52 without the necessity of a water feed pump. Of course, such a pump could be used. The residence time of the water in the cartridge 1 is controlled by the control means 16 and the design of the free volume of the cartridge 1. If a water pump is used, the control means 16 can cause this pump to supply water to the cartridge when appropriate. Residence times of water within the cartridge 1 are in the order of 1-60 minutes as noted above.

The product water 20 enters storage tank 26 from the heat exchanger 18. An air cushion 27 is provided within the storage tank 26. Head-space gases such as air are found in this cushion 27. This air cushion is separated from the stored water 28 by a movable hermetic barrier 29. Barrier 29 contacts the water in water chamber 56 and follows changes in water volume. This barrier 29 will therefore keep the water in the storage tank out of contact with head-space gases. A gaseous head-space will not be permitted to be formed above and in contact with the water. The barrier 29 will permit water storage without recontamination of the water with atmosphere.

This movable barrier 29 can be a flexible membrane, a floating platform on the surface of the water in tank 26 or any other suitable structure. If a flexible membrane is used as the barrier 29, it can be made from plastic, rubber or any suitable material. The air cushion 27 is trapped in the head-space of the storage tank 26. Pressure of the air cushion 27 therefore increases as the quantity of stored water 28 increases.

In very small installations, where control simplification is desired, the controls described below can be simplified by allowing the pressure of the air cushion 27 to stop the water flow once this pressure has reached equilibrium with the water main pressure. In such an arrangement, the flow would automatically restart when stored water 28 is withdrawn and the pressure of the air cushion 27 falls. In such a case, cartridge 1 must be oversized in capacity to deal with the condition of cold starting.

Alternatively, as shown in Figure 2, instead of an air cushion 27, the barrier 29 can move an actuator 30. This actuator 30 can be a vertically movable

platform within the storage tank 26. Upon reaching a certain height, the actuator 30 will trigger a level switch 31. The level switch 31 is part of the control system of the apparatus described below. When it is necessary to operate with cartridge 1 having a temperature above 100°C., a back pressure on the cartridge 1 can be provided by a simple, conventional spring-relief valve 32.

The purpose of barrier 29 is to permit water storage without recontamination of the water as noted above. The water is out of contact with the ambient environment. Air within the storage tank (such as air-cushion 27) is kept out of contact with the stored water 28. The barrier can also prevent the formation of a gaseous head-space in contact with the water in chamber 56.

The purpose of the storage tank 26 is to enable the sizing of cartridge 1 and its heaters (6 or 6a) to be minimal and compact, by not needing to meet pre-draw requirements. One purpose of the air cushion 27 is to provide a back pressure on the cartridge 1. This will enable operating temperatures in the cartridge above 100°C, similarly to the spring-relief valve 32.

In case of electrical heating as shown in Figure 1, heaters 6 or 6a can be sized to provide fixed heat generation consisting of required sensible heat, plus a small amount of evaporation, plus heat losses. Solenoid-operated stop valve 35 is located in the removable head 9. This stop valve 35 is closed whenever cartridge 1 is below the correct temperature of water treatment. In such a condition, no steam will be generated in its head-space. Such steam is detected by thermal switch 36 located immediately after head 9.

When thermal switch 36 detects steam, the stopvalve 35 opens to permit treated water to flow from cartridge 1. When storage tank 26 is full, the air cushion 27 reaches maximum pressure. This can be detected by pressure switch 37 or level switch 31. Either switch can close a stop valve 35 and turn off the heater 6 or 6a.

As the stored water 28 is withdrawn from the storage tank 26, the pressure on the air cushion 27 falls. The heater 6 or 6a will then be switched back on. However, stop valve 35 does not immediately open. This valve 35 is kept closed by thermal switch 36 until steam is generated and the correct treatment temperature is established. The effluent gases ducted in pipe 10 of Figure 1 contain mainly steam. These gases are condensed in a finned coiled tube 39. The condensate collects in drip tray 40. In the embodiment shown in Figure 2, the air cushion 27 is replaced by an actuator 30 and the level switch 31 performs all the functions described for the pressure switch 37.

Turning now to Figure 3, a simple on/off thermostat system can instead be used. Because many of the elements in the embodiment of Figure 3 are the same as those of Figure 1, their description will now be omitted. The on/off thermostat system of Figure 3 is used when the heat capacity of the heater 6 or 6a is low enough to permit good temperature control. In this case, the thermal switch 36 is located within the headspace 11 of cartridge 1. This thermal switch 36 will switch heater 6 or 6a on and off by an electrical switch 38.

Figure 1 indicates a dispenser 50 connected to the stored water 28 in storage tank 26. It should be noted that water flows directly from the cartridge 1 to the storage tank 26 and then to the this dispenser 50 without the need for additional treatment. In particular, there is no chemical treatment of the water after it leaves the cartridge 1. Moreover, chemicals are not added to the cartridge to treat the water therein. Conventional carbon/sand filtration is avoided in the present apparatus while increased water treatment quality criteria are met.

The dispenser 50 indicated in Figure 1 is merely shown as a block diagram. It should be clear to one of ordinary skill in the art that various dispensing arrangements may be incorporated as such a dispenser. Treated water released from this dispenser 50 can be used in a post-mix beverage dispenser. In fact, household or in-store users can tap the water from the storage tank 26 and drink it as treated water without the water going to dispenser 50. This treated water could therefore be used for domestic drinking or cooking purposes.

Turning now to Figure 4, an alternate heating arrangement is shown. Because many of the elements in the embodiment of Figure 4 are the same as those of Figure 1, their description will now be omitted. Gas heating is used in this embodiment of Figure 4 instead of internal heater 6. An external heating-mantle 6a may or may not be used depending upon the heating requirements of the apparatus.

Cartridge 1 and head 9 have an internal chimney 44 in the embodiment of Figure 4. Thermal switch 36 is located in the head-space 11 of cartridge 1. This thermal switch 36 will switch gas valve 45 on and off. The gas flame will then be lit by spark plug 46 and ignition will be controlled in a conventional manner to ensure safe operation. The gas supply for the flame can be provided by a gas cylinder 47. The gas cylinder 47 is located beneath the internal chimney 44. The gas cylinder 47 and gas valve 45 are a part of the heater means of the Figure 4 embodiment.

The arrangement of Figure 4 is easily portable and can be used in many different applications. For example, this arrangement can be used at fairs, picnics or other locations where electrical power is not readily available. If an external heating mantle 6a is also provided, this Figure 4 embodiment can also
5 readily be used when electrical power is available and gas heating is not desired.

Apart from the water treatment apparatus of the present invention, a water treatment method is provided. In this water treatment method, water is introduced into the cartridge 1 and passed through the mesh structure 2. The water is heated by either the internal heater 6, by the external heating-mantle 6a
10 or by a flame from gas cylinder 47. This heating will cause breakdown of bicarbonate hardness of the water. A collector or mesh structure 2 is provided on which the bicarbonate and other precipitates can be deposited. Gases disentrained from the water are collected in head-space 11. Storage tank 26 is provided to receive the water from the outlet of the cartridge 1. This water is
15 kept out of contact with air or other gases in a head-space of the storage tank 26 by providing a collapsible water chamber 56 including hermetic barrier 29. This barrier 29 contacts the water in the storage tank 26 and follows changes in water volume in the water chamber 56.

The method of the invention further includes the steps of introducing
20 water into the housing or cartridge 1. A collector or mesh structure 2 and head-space 11 are provided in the housing. The water is heated by either the internal heater 6, by the external heating mantle 6a or by a flame from gas cylinder 47. This heating will cause breakdown of the bicarbonates in the water which will be deposited on the mesh structure or collector 2. Heavy metals will
25 be codeposited on this mesh structure 2 due to the resultant change in pH of the water. Gases disentrained from the water are collected in head-space 11. The water is maintained in the cartridge 1 for a predetermined period of time. The water is heated during at least this predetermined period of time, usually 10-60 minutes. The water will then be supplied from housing or cartridge 1 directly to
30 storage tank 26. The water in the storage tank 26 is kept out of contact with air or other gases in the headspace of tank 26 by the barrier 29. This barrier 29 is in contact with the water and follows changes of water volume in the water chamber 56 of the tank 26.

The water in storage tank 26 can be discharged through dispenser 50.
35 There is no chemical treatment of the water from the cartridge 1 to the storage

tank 26 and the dispenser 50. Treatment of water quality is substantially completed when the water leaves cartridge 1.

Apart from the above-described methods, the present-invention also provides for a method for treating water for use in a post-mix beverage dispenser wherein the ability of the system to treat the water can be monitored. In this method, water is also introduced into housing or cartridge 1. The water will move through the housing by first flowing through the collector or mesh structure 2 and then through the filter 22. The filter 22 has a shorter useful life than the collector. The internal heater 6, the external heating-mantle 6a or the flame from gas cylinder 47 will heat the water within housing or cartridge 1. Bicarbonate hardness of the water will be broken down and carbonates will be deposited on the collector or mesh structure 2 thereby gradually reducing its proper functioning. A condition of the filter 22 will change as a function of the depositing of the bicarbonates on the mesh structure 2 such that the filter 22 will monitor the condition of the filter. The filter 22 will become completely blocked before the mesh structure 2 to thereby stop the flow of water. This blocked filter 22 will therefore signal the need for maintenance of the collector or mesh structure 2. Because the flow of water will terminate, a user will be forced to replace a spent cartridge 1.

An alternative water treatment system 110 according to another embodiment of the present invention is illustrated in Fig. 6. The structure and operation of this alternative water treatment system 110 is similar to the system illustrated in Fig. 1, but is also different in many respects as will be explained below. Generally, the alternative water treatment system 110 comprises an enclosure 112, a disposable and replaceable water treatment cartridge 114, a heat exchange cartridge 116, an intercooler 118, a condenser 120, and a treated water reservoir 121.

The enclosure 112 is desirably of sturdy construction such as stainless steel, plastic, wood or other types of metal, and has an access opening 122 which can be sealed by a door 124. The enclosure 112 is divided into a water treatment compartment 126 and a cooling compartment 128 by a vertical panel 130. Vents 132 at the top and bottom of the cooling compartment 128 allow cooling air flow through the cooling compartment.

The disposable water treatment cartridge 114 is similar in operation and structure to the cartridge 1 illustrated in Fig. 2 and described hereinabove; however, there are some differences. The water treatment cartridge 114 shown

in Fig. 6 comprises a housing 133 including a metal cylinder or can 134 which removably attaches to a circular head 136 attached to a mounting panel 138 in the enclosure 112. The mounting panel 138 extends between the vertical panel 130 and a side wall of the enclosure. An untreated water inlet 140 extends through the head 136 of the cartridge housing 133 and into the water treatment chamber 137. The untreated water inlet 140 discharges untreated water toward the lower end of the cartridge housing 133. A treated water outlet 142 extends from within the water treatment chamber 137 through the head 136 of the cartridge housing 133.

10 A water submersible electric heater 144 is disposed in the cartridge housing 133 proximate the lower end of the housing. Electrical contacts 146 extend through the metal cylinder 134 of the housing 133 for connection to an electric power source. The heater 144 is disposed in the housing for direct contact with water in the housing and is disposable along with the remainder of the cartridge 114. As with the embodiments described hereinabove, the heater 144 is operable for heating water in the water treatment chamber 137 of the cartridge 114 sufficiently to convert dissolved impurities in the untreated water to solid precipitates and gases.

20 A collector 148 comprising a steel or plastic mesh is disposed in the cartridge housing 133 between the heater 144 and the head 136. As with the previous embodiments, the collector collects at least a portion of the solid precipitates deposited from the water during treatment of the water. A polishing filter 150 is disposed in the cartridge housing 133 on top of the collector 148 and, as in the previous embodiments described herein, collects the relatively fine portion of the precipitates deposited from the water during treatment. The polishing filter 150 can comprise a variety of materials as described with regard to the previous embodiment, but preferably comprises polyester wool.

30 As in the previous embodiment, the polishing filter 150 of this water treatment system 110 has a shorter useful life than the collector 148. The untreated water inlet 140 discharges untreated water below the collector 148 and the treated water outlet 142 collects treated water above the polishing filter 150 so that the water discharged by the untreated water inlet must flow first through the collector and then through the polishing filter. The polishing filter 150, having a fine porous structure, becomes blocked with precipitates before the collector 148 becomes blocked. As will be explained in more detail below, this blockage indicates that the cartridge 114 must be replaced.

A gas outlet valve 152 in the head 136 of the cartridge housing 133 periodically discharges gases from the head space 154 of the cartridge 114 through a gas outlet 153. As with the previously described embodiment, these gases include steam, carbon dioxide, and other impurities released from the water during treatment.

A lower water level sensor 156 is disposed in the water treatment cartridge housing 133 above the polishing filter 150 and an upper water level sensor 158 is disposed in the water treatment cartridge housing above the lower level sensor. As will be explained further below, these water level sensors 156 and 158 indicate the water level in the water treatment cartridge 114 and indicate the degree of blockage of the polishing filter 150.

A temperature measuring device 160, such as a thermocouple, is also disposed in the water treatment chamber 137 of the cartridge housing 133 for measuring the temperature of the water in the water treatment chamber. A steam detector 162 such as a thermal switch is disposed in the gas outlet 153 to detect the generation of steam by the water treatment cartridge 114.

The heat exchange cartridge 116 is disposed in the water treatment compartment 126 of the enclosure adjacent the water treatment cartridge 114 and comprises a housing 164 including a metal cylinder or can 165 and a head 166. The cylinder 165 removably attaches to the head 166. The heat exchange cartridge 116 also includes a coiled tube 168 for receiving treated water from the water treatment cartridge 114. The coiled tube 168 extends between a treated water inlet 170 extending through the head 166 of the housing 164 and a treated water outlet 172, which extends through the head 166 of the housing inside an untreated water inlet 174. Untreated water enters the heat exchange cartridge housing 164 through the untreated water inlet 174 in the head 166. The untreated water inlet 174 discharges the untreated water near the bottom of the heat exchange cartridge housing 164. An untreated water outlet 176 also extends through the head 166 of the heat exchange cartridge housing 164 and connects with the untreated water inlet 140 of the water treatment cartridge 114.

The intercooler 118 is disposed in the cooling compartment 128 of the enclosure 112 and includes a coiled tube 178 connected to the treatment water outlet 142 of the water treatment cartridge 114 via conduit 180. A fan 182 disposed in the cooling compartment 128 forces air flow through the cooling compartment 128 between the vents 132 in the enclosure 112.

The condenser 120 is also disposed in the cooling compartment 128 of the enclosure 112 and comprises tubing 184 extending from the gas outlet 153 in the water treatment cartridge 114 to an outlet 186 in the enclosure 112.

Raw untreated water is introduced into the water treatment system 110 via a water main 188 which leads to the untreated water inlet 174 of the heat exchange cartridge 116.

Cooled treated water from the heat exchange cartridge 116 is discharged through the reservoir 121 via an exit conduit 196. The reservoir 121 comprises a housing 198 and a plastic bag 200 disposed in the housing for receiving the treated water. As with the previous embodiments, the plastic bag 200 protects the treated water from biological recontamination. A level sensor 202 is disposed in the reservoir housing 198 and detects the level of treated water in the reservoir 121.

The diagram in Fig. 7 illustrates a visual display 208 for indicating the status of the water treatment system 110. A computer control board 210 monitors the various detectors and measuring devices in the water treatment system 110 and, based on data from the detectors and measuring devices, commands a visual display of the system's status via three lights or LEDs 212, 214, and 216. Although any number of lights and colors can be used to display the status of the water treatment system 110, this embodiment has three lights, one green, one yellow and one red. Each light is capable of emitting a steady light or a flashing light. The operation of the water treatment system 110 and the visual display 208 is described hereinafter.

Raw untreated water enters the water treatment system 110 through the water main 188 and is discharged through the untreated water inlet 174 of the heat exchange cartridge 116 into the housing 164 of the heat exchange cartridge proximate the bottom of the heat exchange cartridge housing. The untreated water is heated in the heat exchanger from a temperature of about 25°C to about 80°C. The heated untreated water is discharged from the heat exchange cartridge 116 through the untreated water outlet 176 which connects to the untreated water inlet 140 of the water treatment cartridge 114.

The heated untreated water is discharged into the water treatment cartridge housing 133 below the steel mesh collector 148 in the water treatment cartridge housing. The heater 144 in the water treatment chamber 137 heats the untreated water to a temperature of about 115°C. The water slowly flows up to the top of the water treatment cartridge 114 through the collector 148 and the

polishing filter 150. The minimum residence time of water in the water treatment cartridge 114 is about six minutes. As explained with the foregoing embodiment, heating the water causes precipitates such as carbonates and heavy metals to deposit on the heated surfaces of the water treatment cartridge. The
5 coarser, heavier particles tend to settle at the bottom of the cartridge housing 133 and finer particles collect on the collector 148 and the polishing filter 150. In addition, as the water in the water treatment cartridge 114 heats, entrained gases are released from the water into the head space 154 of the cartridge and steam forms in the head space of the cartridge. As with the previously described
10 embodiment, when the temperature of the water in the water treatment cartridge 114 reaches 115°C and the thermal switch 162 detects steam in the gas outlet 152, a valve in the gas outlet is opened and releases steam and other gases to the condenser 120.

Gases in the condenser 120, such as steam, are cooled in the condenser
15 by the forced air flow in the cooling compartment 128 created by the fan 182. The condensants are discharged into a drip pan (not shown) or directly to drain.

Treated water is discharged from the water treatment cartridge housing 133 through the treated water outlet 142 and fed to the intercooler 118. The treated water is cooled in the intercooler 118 by the forced air produced by the
20 fan 182 in the cooling compartment 128 from a temperature of about 115°C to about 80°C. The intercooler 118 discharges the treated water into the coiled tube 168 of the heat exchange cartridge 116 through the treated water inlet 170. The treated water travels through the inside of the coiled tube 168 and is cooled from a temperature of about 80°C to about 25°C by the counter-flowing untreated
25 water from the water main 188.

The cooled treated water is then discharged from the heat exchange cartridge 116 through the treated water outlet 172 and conducted to the reservoir 121. The treated water is held in the reservoir bag 200 until the treated water is dispensed, such as for use in making fountain beverages.

30 The purpose of the intercooler 118 is to cool the treated water to a temperature sufficiently low so as not to cause hardness in the untreated water passing through the heat exchanger to precipitate and form scale in the heat exchange cartridge 116 and the conduits feeding the untreated water from the heat exchange cartridge 116 to the water treatment cartridge 114.

35 The visual display 208 is capable of indicating a plurality of statuses of the water treatment system 110 during the operation of the water and service of

the water treatment system. When power to the water treatment system 110 is turned on with an on/off switch 220, the green light 212 of the visual display 208 comes on and emits a steady light. As the water treatment cartridge 114 begins to fill with water, the yellow light 214 comes on and emits a steady yellow light until the water treatment cartridge 114 has enough water to cover the lower water level sensor 156. The control board 210, based on data from the lower water level sensor 156 in the water treatment cartridge 114, turns off the steady yellow light 214 when the lower water level sensor is covered with water.

The control board 210 also monitors the water level sensor 202 in the reservoir 121 and until the reservoir has enough water to cover the water level sensor in the reservoir, the control board causes the yellow light 214 to flash. Once the control board 210 detects that the water level sensor in the reservoir is covered in water, the control board turns off the flashing yellow light 214.

The control board 210 monitors the temperature data from the thermocouple 160 in the water treatment cartridge 114 and the thermal switch 162 in the gas outlet 153 and when the temperature of the water in the water treatment cartridge reaches 115°C and steam is detected in the gas outlet, the control board directs the treated water outlet valve to discharge treated water to the reservoir 121 and causes the green light 212 of the visual display 208 to flash. When the treated water outlet valve closes and water generation ceases, the control board directs the green light 212 to emit a steady light indicating that the water treatment system power is on.

The control board 210 monitors data from the lower and upper water level sensors 156 and 158 in the water treatment cartridge 114 and calculates the time required for water to rise from the lower level sensor to the upper level sensor. The time required for the water to rise indicates the degree of blockage of the polishing filter 150. The control board 210 compares the time required for the water to rise between the lower and upper water level sensors 156 and 158 and compares it to a predetermined time which indicates a degree of blockage of the polishing filter 150 and gives a visual indication of the degree of blockage. For example, when the time required for the water to rise indicates that the polishing filter 150 is 90% blocked, the control board 210 causes the red light 216 of the visual display to flash. Further, when the control board 210 detects that the time required for the water to rise indicates that the polishing filter 150 is completely blocked, the control board causes the red light 216 to emit a steady red light and turns the water treatment system off.

Upon recognizing from the visual display that the water treatment cartridge 114 is blocked, the operator can activate a cooling mode with a switch 222 that turns on the untreated water flow through the system but does not turn on the heater 144. Cool water then circulates throughout the water treatment system and lowers the temperature of the water treatment system. The control board 210 monitors the cool down switch 222 and when the cool down mode is detected, the control board flashes all three lights 212, 214, and 216, in sequence. The control board 210 continues to monitor the temperature of the water in the water treatment cartridge 114 and, when the temperature drops below a predetermined number, such as 50°C, the control board causes all three lights 212, 214, and 216 of the visual display to flash simultaneously to indicate that the temperature of the water treatment system 110 is low enough for the operator to open the door 124 of the enclosure of 112. In addition, upon detecting that the temperature of the water in the water treatment cartridge 114 has dropped below the predetermined temperature, the control board unlocks an automatic locking mechanism 224 which prevents the operator from opening the door 124 of the enclosure 112 during operation of the water treatment system.

The apparatus and method of the present invention required little control, are simple to maintain and operate and are relatively inexpensive. In particular, the disposable cartridge 1 is relatively simple and the non-disposable contents of the apparatus require little maintenance. Therefore, the apparatus can economically treat water without entailing high capital expenditures.

The present apparatus and method reduce water hardness and provide sterile water while removing many impurities of the water. A simple method for in-home or in-store removal of microbiological contaminants, bicarbonate hardness, VOCs/THMs, chlorine, heavy metals and deaeration of water is provided. High reliability in the absence of technical monitoring or controls is obtained. This apparatus and method are simple, convenient and can safely be operated by non-qualified personnel. Moreover, this apparatus and method require only limited space thereby further reducing the overall cost.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

WE CLAIM:

1. A system for treating water comprising:
a housing defining a water treatment chamber and having a water
5 inlet for receiving untreated water and a water outlet for discharging treated
water;
a water submersible heater disposed in the housing so that the
heater is in direct contact with the water in the housing, the heater operable for
heating the water sufficiently to convert dissolved impurities in the untreated
10 water to solid precipitates and gases; and
a collector disposed in the housing for collecting the solid
precipitates deposited from the water.
2. A system for treating water as in claim 1 further comprising a gas
15 outlet for discharging the gases from the housing.
3. A system for treating water as in claim 1 further comprising a
storage tank to receive water from the water outlet of the housing.
- 20 4. A system for treating water as in claim 1 further comprising
providing a collapsible water container for keeping the water stored in the
storage tank out of contact with air or other gases in a head-space of the storage
tank.
- 25 5. A system for treating water as in claim 1 wherein the heater is an
electrical heater.
- 30 6. A system for treating water as in claim 1 wherein the housing,
collector, and heater form a disposable unit which can be disengaged from the
system and replaced.

7. A method for treating water comprising:
feeding untreated water into a water treatment chamber defined
by a housing through a water inlet in the housing;
heating the untreated water fed into the water treatment chamber
5 with a water submersible heater disposed in the housing so that the water directly
contacts the heater, the water being heated sufficiently to convert dissolved
impurities in the untreated water to solid precipitates and gases; and
collecting the solid precipitates deposited from the water onto a
collector disposed in the housing; and
10 discharging treated water from the housing through a water outlet
in the housing.
8. A method for treating water as in claim 8 further comprising
15 discharging the gases from the housing through a gas outlet in the housing.
9. A method for treating water as in claim 8 further comprising
discharging treated water from the water outlet of the housing into a storage
tank.
- 20 10. A method for treating water as in claim 9 further comprising
providing a collapsible water container for keeping the water stored in the
storage tank out of contact with air or other gases in a head-space of the storage
tank.
- 25 11. A method for treating water as in claim 8 wherein the heater is an
electrical heater.
- 30 12. A method for treating water as in claim 1 wherein the housing,
collector, and heater form a disposable unit, and the method further comprises
disengaging the disposable unit from the system and replacing the disposable
unit.

13. A system for treating water comprising:
a housing defining a water treatment chamber and having a water inlet for receiving untreated water and a water outlet for discharging treated water;
- 5 a heater for heating the water sufficiently to convert dissolved impurities in the untreated water to solid precipitates and gases;
a collector disposed in the housing for collecting a first portion of the solid precipitates deposited from the water; and
a polyester wool filter disposed in the housing for collecting a
10 second portion of the solid precipitates deposited from the water, the water first flowing through the collector and then through the filter, the filter having a shorter useful life than the collector so that the filter becomes blocked with the precipitates before the collector becomes blocked with the particulates.
- 15 14. A method for treating water comprising:
feeding untreated water into a water treatment chamber defined by a housing through a water inlet in the housing;
heating the water with a heater sufficiently to convert dissolved
impurities in the untreated water to solid precipitates and gases; and
20 collecting a first portion of the solid precipitates deposited from the water on a collector disposed in the housing;
collecting a second portion of the solid precipitates on a polyester wool filter disposed in the housing deposited from the water, the water first
25 flowing through the collector and then through the filter, the filter having a shorter useful life than the collector so that the filter becomes blocked with the precipitates before the collector becomes blocked with the particulates; and
discharging treated water from the housing through a water outlet in the housing.

30

15. A system for treating water comprising:
a housing defining a water treatment chamber and having a water inlet for receiving untreated water and a water outlet for discharging treated water;
5 a heater for heating the water in the housing sufficiently to convert dissolved impurities in the untreated water to solid precipitates and gases;
a collector disposed in the housing for collecting the solid precipitates deposited from the water;
10 a water cooler for receiving treated water from the housing water outlet; and
a fan for forcing air past the water cooler to cool the treated water in the water cooler.
- 15 16. A system for treating water as in claim 15 further comprising a gas outlet for discharging the gases from the housing and a condenser for receiving the gases discharged from the gas outlet, the fan positioned for forcing air past the condenser to cool the gases in the condenser.
- 20 17. A system for treating water as in claim 15 further comprising a heat exchanger for exchanging heat between treated water discharged from the water cooler and untreated water being fed into the housing.
- 25 18. A system for treating water as in claim 15 wherein the cooler comprises a coiled pipe.
19. A system for treating water as in claim 17 wherein the condenser comprises a coiled pipe.

20. A method for treating water comprising:
feeding untreated water into a water treatment chamber defined
by a housing through a water inlet in the housing;
heating the water in the housing with a heater sufficiently to
5 convert dissolved impurities in the untreated water to solid precipitates and
gases; and
collecting the solid precipitates deposited from the water on a
collector disposed in the housing;
discharging treated water from the housing through a water outlet
10 in the housing;
feeding treated water from the housing water outlet through a
water cooler; and
forcing air past the water cooler to cool the treated water in the
water cooler.
15
21. A method for treating water as in claim 20 further comprising
discharging the gases from the housing through a gas outlet and a condenser, and
forcing air past the condenser to cool the gases in the condenser.
- 20 22. A method for treating water as in claim 20 further comprising
exchanging heat in a heat exchanger between treated water discharged from the
water cooler and untreated water being fed into the housing.
23. A system for treating water as in claim 20 wherein the cooler
25 comprises a coiled pipe.
24. A system for treating water as in claim 21 wherein the condenser
comprises a coiled pipe.

30

25. A system for treating water comprising:
a housing defining a water treatment chamber and having a water inlet for receiving untreated water and a water outlet for discharging treated water;
5 a heater for heating the water in the water treatment chamber sufficiently to convert dissolved impurities in the untreated water to solid precipitates and gases;
a collector disposed in the housing for collecting the solid precipitates deposited from the water;
10 a reservoir to receive treated water discharged from the water outlet of the housing; and
a visual display for indicating a status of the system.
26. A system for treating water as in claim 25 wherein the visual display comprises a plurality of lights for indicating the status of the system.
27. A system for treating water as in claim 26 wherein the visual display is capable of indicating any one of a plurality of possible statuses of the system.
28. A system for treating water as in claim 27 wherein the statuses include the level of water in the housing.
29. A system for treating water as in claim 28 wherein the visual display indicates when the water in the housing is below a predetermined level.
30. A system for treating water as in claim 28 wherein the visual display indicates when the water in the housing is above a predetermined level.
31. A system for treating water as in claim 28 further comprising a water level sensor disposed in the housing for communicating to the visual display the water level in the housing.
32. A system for treating water as in claim 27 wherein the statuses include the level of water in the reservoir.

33. A system for treating water as in claim 32 wherein the visual display indicates when the water in the reservoir is below a predetermined level.

5 34. A system for treating water as in claim 32 further comprising a water level sensor disposed in the reservoir for communicating to the visual display the water level in the reservoir.

10 35. A system for treating water as in claim 27 further comprising a fine filter disposed in the housing for filtering precipitates from the water in the housing, wherein the statuses include the level of precipitate blockage in the fine filter.

15 36. A system for treating water as in claim 27 wherein the statuses include treated water discharge status.

37. A system for treating water as in claim 36 wherein the visual display indicates when the housing discharges treated water.

20 38. A system for treating water as in claim 27 wherein the statuses include system cooling status.

25 39. A system for treating water as in claim 38 further comprising a switch for turning the heater off while unheated water flows through the system to cool the system.

40. A system for treating water as in claim 38 wherein the visual display indicates when the water in the housing is below a predetermined temperature.

30 41. A system for treating water as in claim 40 further comprising an enclosure, the housing disposed in the enclosure, a door for providing access to the enclosure, a lock which selectively locks the door when the water in the housing is at least the predetermined temperature, and alternatively, unlocks the door when the water in the housing is below the predetermined temperature.

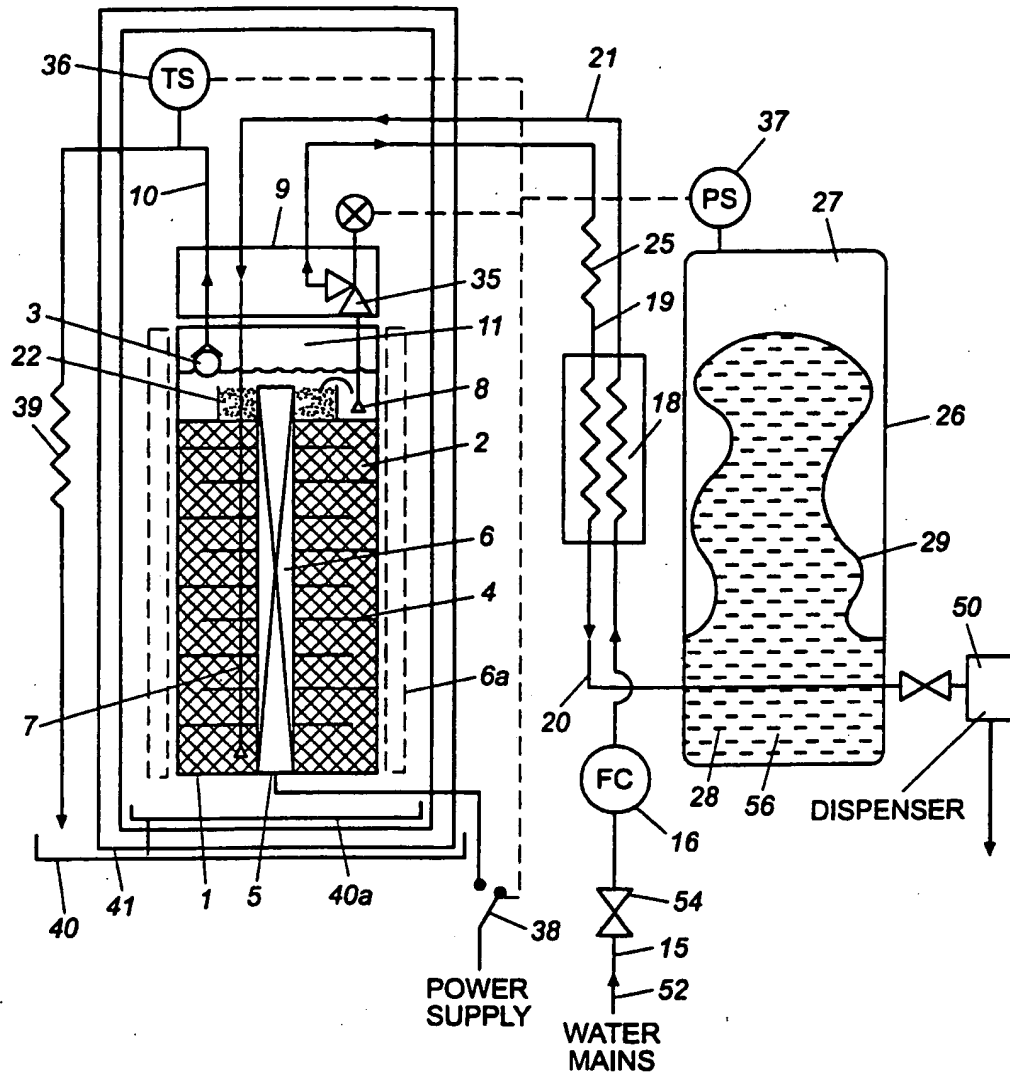
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42. A system for treating water as in claim 27 wherein the statuses include the level of water in the housing, the level of water in the reservoir, the temperature of the water in the water treatment chamber, the level of blockage in the housing, treated water discharge status, system power on/off status, and
5 system cooling status.

43. A method for treating water comprising:
feeding untreated water into a water treatment chamber defined
by a housing through a water inlet in the housing;
10 heating the water in the water treatment chamber sufficiently to
convert dissolved impurities in the untreated water to solid precipitates and
gases;
collecting the solid precipitates deposited from the water on a
collector disposed in the housing;
15 discharging treated water from the housing through a water outlet
in the housing;
collecting treated water discharged from the water outlet of the
housing in a reservoir, and
visually displaying a status of the system.

20

44. A method for treating water as in claim 43 wherein the step of visually displaying comprises indicating the status of the system with a plurality of lights.



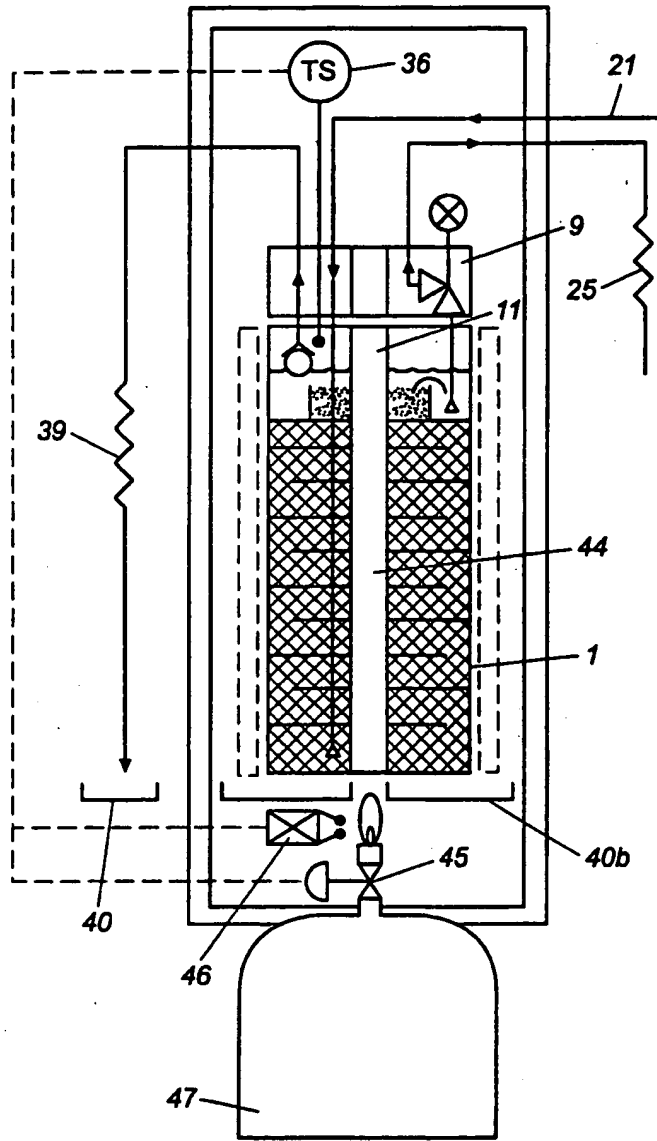


Fig. 4

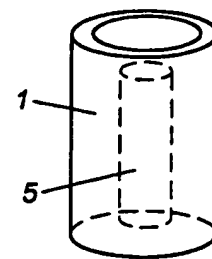


Fig. 5

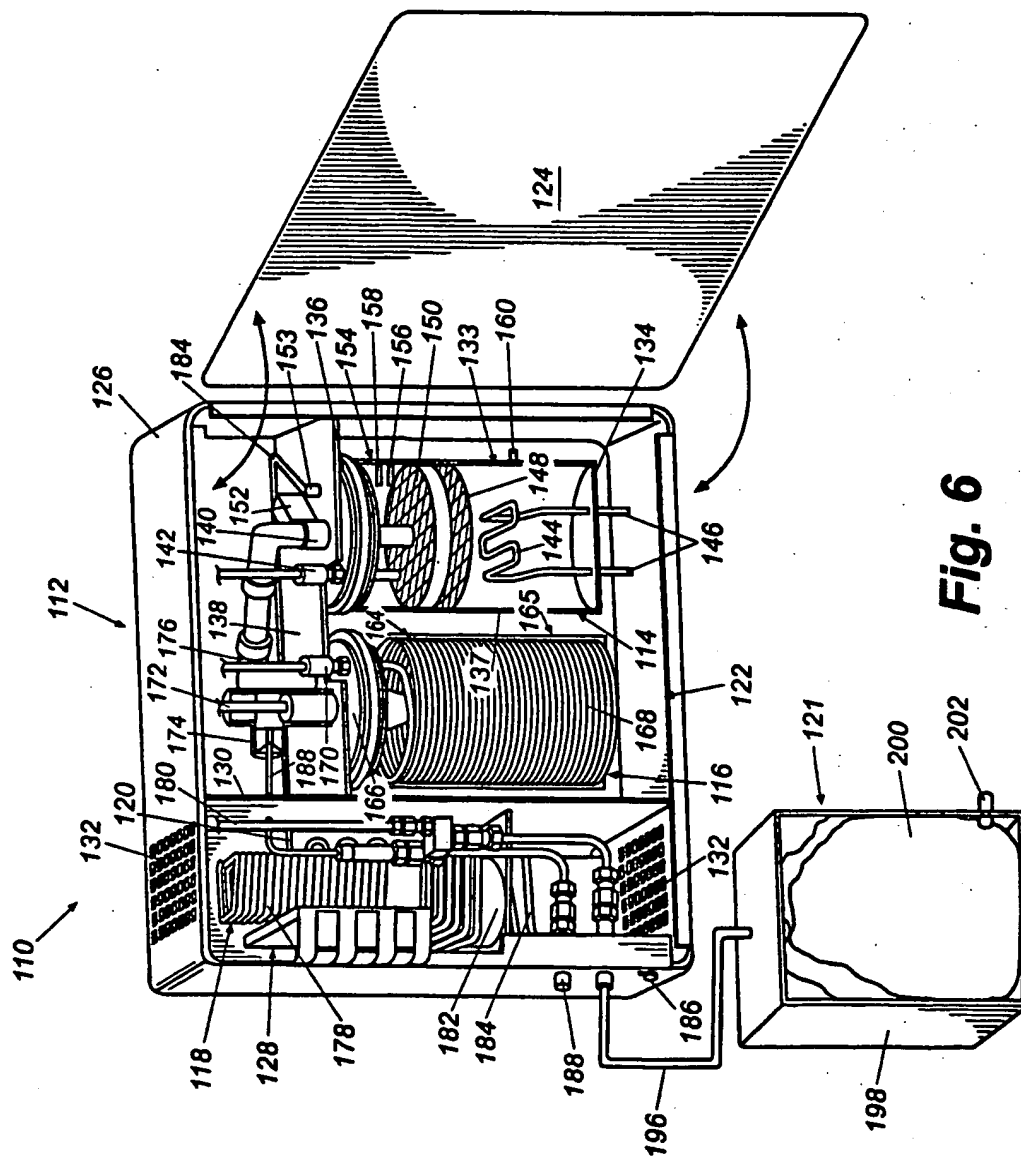


Fig. 6

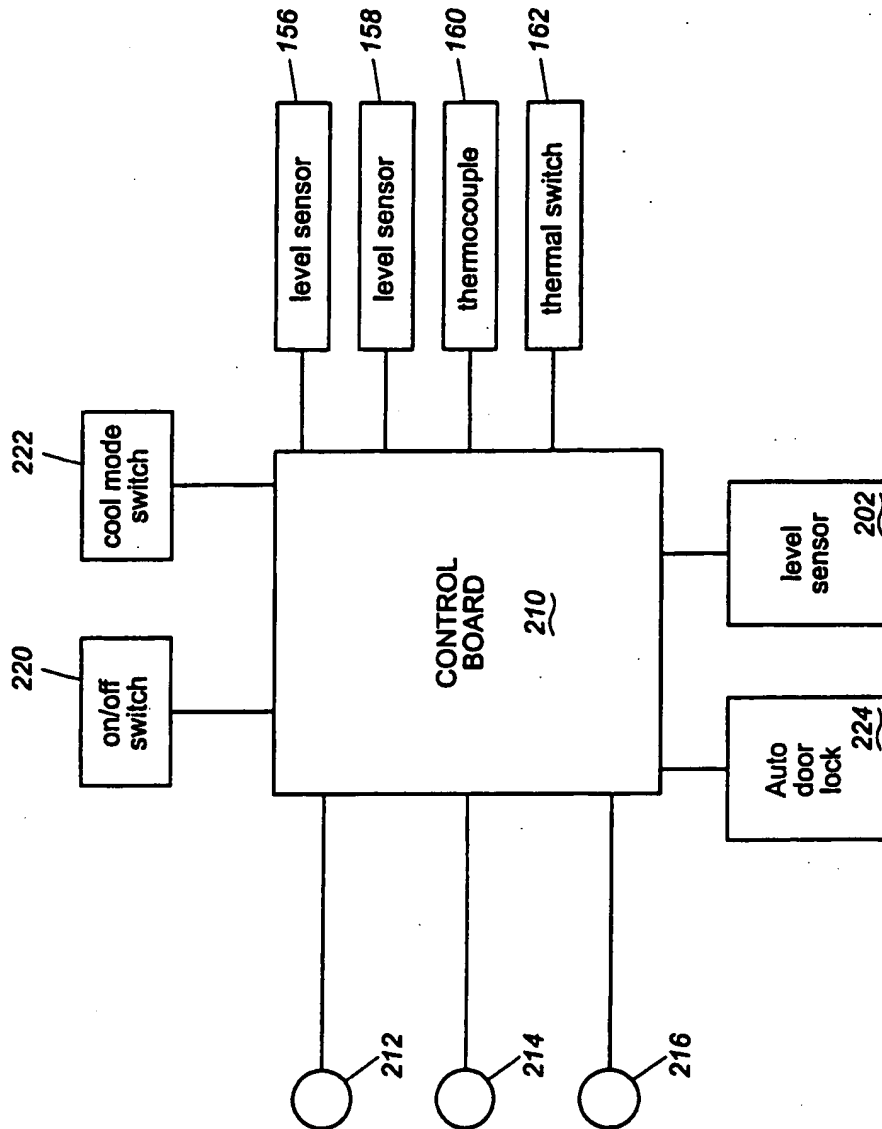


Fig. 7

INTERNATIONAL SEARCH REPORT

Int. Jonal Application No

PCT/US 00/21422

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C02F1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 858 248 A (PLESTER GEORGE ET AL)	1-5,7-11
Y	12 January 1999 (1999-01-12)	13,14,
	the whole document	25-40,
A		43,44
		6,12,
		15-24,
		41,42

X	EP 0 337 455 A (ARKAY CORP OF WISCONSIN)	1,2,5,6
Y	18 October 1989 (1989-10-18)	25-40
A	the whole document	7-24,
		41-43

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

29 November 2000

Date of mailing of the international search report

12 12 2000

Name and mailing address of the ISA

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/21422

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 96 24390 A (IC INGENIEUR CONSULT TECH GESA ;SCHMIDT REINHARD (DE)) 15 August 1996 (1996-08-15)	25-34, 36-40, 43,44
A	page 6, paragraph 4 -page 8, paragraph 1; figure 1	15,16, 41,42
Y	US 5 679 243 A (CHO MOON-HYUN) 21 October 1997 (1997-10-21) the whole document	25,27,35
Y	US 5 587 055 A (HARTMAN MICHAEL O ET AL) 24 December 1996 (1996-12-24)	25-34, 36,37
A	column 5, line 39-59	38-44
Y	DE 195 34 454 A (BRITA WASSERFILTER) 20 March 1997 (1997-03-20) column 6, line 25-38; figure 1	13,14
A	US 4 957 200 A (TURNER WILLIAM F ET AL) 18 September 1990 (1990-09-18) the whole document	15-24
A	US 5 837 147 A (JOUNG GEUM-SUK) 17 November 1998 (1998-11-17) column 3, line 56 -column 4, line 8; figures 1,2	15-24
A	US 5 755 957 A (JEON JE-DAL) 26 May 1998 (1998-05-26) column 4, line 9-63; figure 5	25-36

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 00/21422

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-14

Process and system for treating water comprising a heater for heating water sufficiently to convert dissolved impurities to solid precipitates and gases and a collector for the solid precipitates

2. Claims: 15-24

Matter of subject 1 and a water cooler for cooling the treated water and a fan for forcing air past the water cooler to cool the treated water in the water cooler

3. Claims: 25-44

Matter of subject 1 and a visual display for indicating the status of the system

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. .onal Application No

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